Quality Assurance Project Plan

Bioaccumulative Chemicals in Hatchery Feed and Hatchery Fish

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Bioaccumulative Chemicals in Hatchery Feed and Hatchery Fish

May 2005

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Approvals

Approved by:	March 17, 2005
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Stuart Magoon, Director, Manchester Environmental Laboratory	Date
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Abstract

Recent reports have indicated that feed used to raise hatchery and commercially farmed salmonids may contain PCBs and other bioaccumulative toxic chemicals. Currently, there is no program to evaluate toxic chemicals in hatchery feed or hatchery fish. The proposed study will evaluate bioaccumulative chemicals in feed and catchable rainbow trout from Washington Department of Fish and Wildlife hatcheries. Rainbow trout from lakes planted with hatchery fish will also be analyzed to assess contaminant depuration or uptake subsequent to planting.

Background

Recent reports have indicated that feed used to raise hatchery and commercially farmed salmonids may contain PCBs and other bioaccumulative toxic chemicals. For instance, Hites et al., (2004) showed that salmon raised in netpens had substantially higher PCBs than those caught wild, presumably due to PCB-contaminated feed. Carline et al., (2004) found that concentrations of PCBs in hatchery rainbow trout (*Oncorhynchus mykiss*) fillets were correlated to concentrations in feed, and nearly all the body burden was due to PCBs in the diet. Other investigations have revealed detectable concentrations of dioxins, dieldrin, endrin, and mercury as well as PCBs in hatchery broodstock salmon and trout (Millard et al., 2004). In Pennsylvania, PCB contamination of edible tissues accumulated through dietary uptake in hatcheries exceeded thresholds for issuance of consumption advisories (Carline et al., 2004).

To date, there is no evidence that fish from hatcheries in Washington State have contaminant concentrations high enough to warrant advisories for human consumption. However, there is no statewide program to evaluate toxic chemicals in hatchery feed or hatchery fish, no available data on chemical concentrations in hatchery fish, and only anecdotal information on contamination of feed. At the same time, more and more data are emerging which show detectable, albeit low, levels of toxic chemicals in fish from a variety of lakes and streams across the state (e.g. Seiders, 2003; Seiders and Kinney, 2004). In most instances concentrations are not high enough to draw the attention of the Washington State Department of Health--the agency responsible for conducting human health risk assessments--yet concentrations are often high enough to exceed water quality standards. As a result, waterbodies are often included on the Federal Clean Water Act 303(d) list of impairment which generally requires cleanup and control of contaminant sources even though none may be evident.

Many of the bioaccumulative toxicants found in fish tissue (e.g. PCBs, dioxins, mercury) are ubiquitous environmental contaminants and may be found globally through atmospheric deposition, historical releases, or food-web cycling. Fish may accumulate low concentrations of these chemicals through one or more of these pathways, although it is nearly impossible to distinguish and quantify these diffuse sources. However, the portion of contaminant burdens accumulated during residence in hatcheries and rearing facilities may be estimated if representative contaminant concentrations in *catchable* fish are assessed. *Catchables*-- typically trout and more commonly rainbow trout--are legal-sized fish released into lakes and streams just prior to the opening of fishing season.

Project Description

The proposed study will evaluate bioaccumulative chemicals in hatchery feed and hatchery fish. Ten WDFW hatcheries raising catchable rainbow trout will be sampled for feed and fish. Rainbow trout will be sampled in early April just prior to planting in lakes. In mid-late June, rainbow trout that had been planted 2½ months prior will be collected from the same lakes to assess subsequent contaminant depuration or uptake.

Feed samples will consist of batch composites from each hatchery. Fish samples will be fillet composites of ten fish from each hatchery or lake. All feed and tissue (fillet) samples will be analyzed for a variety of chlorinated pesticides, PCBs, a select group of polybrominated diphenyl ethers (PBDEs), and lipid content. A subset of feed and tissue samples will also be analyzed for dioxins.

Project Objectives

Project Objectives are to:

1) Measure concentrations of bioaccumulative toxic chemicals in catchable hatchery rainbow trout released to lakes by Washington Department of Fish and Wildlife (WDFW).

2) Measure concentrations of bioaccumulative toxic chemicals in feed used to raise catchable rainbow trout in WDFW hatcheries to assess the correlation between diet and contaminant burdens in tissue.

3) Estimate the degree of contaminant depuration or uptake in catchable rainbow trout 2½ months following release to lakes with no known contaminant sources.

Fulfilling the project objectives will help the Water Quality Program make decisions on listing waterbodies for non-attainment of standards. Data generated from this study may also help Total Maximum Daily Load (TMDL) managers fully assess sources of bioaccumulative chemicals.

Organization and Schedule

Responsibilities

EAP Project Manager – Dave Serdar (360-407-6772)
EAP Field Assistance – Brandee Era-Miller (360-407-6771) and Kristin Kinney (360-407-7168)
Toxics Studies Unit Supervisor – Dale Norton (360-407-6765)
Manchester Laboratory Director – Stuart Magoon (360-871-8801)
Manchester Laboratory Organics Unit Supervisor – Dean Momohara (360-871-8808)
Ecology Quality Assurance Officer – Cliff Kirchmer (360-407-6455)
EIM Data Entry – Carolyn Lee (360-407-6430)

Schedule

Table 1. Schedule for Study of Bioaccumulative Chemicals in Fish Hatcheries (2005).

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Sampling								
Hatchery feed	X							
Pre-plant fish tissue	X							
Post-plant fish tissue			X					
Reporting								
Feed data delivered from MEL*			X					
Pre-plant tissue data delivered from MEL			X					
Feed and tissue data delvered from contract lab			X					
Post-plant tissue data delivered from MEL					X			
Draft study report						X		
EIM data entry							X	
Final study report								X

*MEL=Manchester Environmental Laboratory

Laboratory Budget

Table 2. Estimated Laboratory Budget and Number of Samples for Study of Bioaccumulative Chemicals in Fish Hatcheries.

Analysis	Price*	Hatchery feed	Pre-plant tissue	Post-plant tissue	Total number of samples	Cost
Pest/PCB/PBDE (MEL EMTC list)	$400	10	10	10	30	$12,000
Pest/PCB/PBDE sample duplicate	$400	2	2	2	6	$2,400
Pest/PCB/PBDE matrix spike	$400	1	1	1	3	$1,200
Pest/PCB/PBDE SRM	$400				2	$800
Percent lipids	$31	10	10	10	30	$930
Percent lipids duplicate	$31	2	2	2	6	$186
PCDD/PCDF (Dioxins)	$900	4	4		8	$7,200
PCDD/PCDF duplicate	$900	1	1		2	$1,800
					Total =	$26,516

*Based on 50% MEL discount for planned sampling. Dioxin analysis will be done at a contract laboratory and includes 25% MEL surcharge.

Quality Objectives

Quality objectives for this project are to obtain data of sufficient quality so that uncertainties in contaminant concentration values are minimized and results are comparable among hatcheries, lakes, feed, and fish tissue. Data quality will be enhanced through the field procedures, sample handling, and laboratory quality control described in this sampling plan.

Measurement Quality Objectives

Measurement quality objectives are shown in Table 3. Laboratories are expected to meet all quality control requirements of the analytical methods selected for this project.

Table 3. Measurement Quality Objectives for Analysis of Feed and Tissue.

Parameter	Lowest concentration of Interest	Laboratory control samples (%recov.)	Laboratory duplicates (RPD)	Matrix spikes (% recov.)	Surrogates (% recov.)	Std. reference material (% diff. from certified value)
Chlorinated pesticides	0.1-1* ng/g ww	50-150	≤50	50-150	30-150	25
PCBs (as Aroclors)	2.5 ng/g ww	50-150	≤50	50-150	30-150	25
PBDEs	0.5 **ng/g ww	50-150	≤50	50-150	30-150	na
PCDDs/PCDFs	0.1-1 pg/g ww	50-150	≤50	na	na	na
Percent lipids	0.1%	na	≤20	na	na	na

*except toxaphene (20 ng/g ww)
**except PBDE-209 (2.5 ng/g ww)
na=not applicable

Sampling Design

Fish feed and catchable rainbow trout (8-12 inches) will be sampled from ten WDFW hatcheries in early April 2005. In mid-late June 2005, ten lakes (one lake corresponding to each hatchery) will be sampled for rainbow trout that had been planted 2½ months earlier. Rainbow trout are the target species because they make up the bulk of the freshwater stocking program (WDFW, 2004).

Hatchery selection was based on consultation with John Kerwin, Hatchery Division Manager with WDFW's Fish Program. The hatcheries, listed below, produce high numbers of catchable rainbow trout, are well or spring-fed, and are geographically dispersed throughout the state. If the opportunity arises, rainbow trout from the Trout Lodge facility will also be sampled.

- Arlington
- Chelan
- Columbia Basin (Moses Lake)
- Eells Springs (Shelton)
- Ford
- Mossyrock
- Puyallup
- Spokane
- Tucannon (Pomeroy)
- Vancouver

Criteria for selecting lakes to be sampled are these: 1) Lakes must have no known contaminant sources and low potential for appreciable contamination so that depuration may be measurable; 2) Lakes must have very little, or no, natural rainbow trout production to increase the likelihood that captured trout are those recently planted; 3) Fish should originate from a single hatchery; and 4) Lakes will be dispersed geographically to reflect a variety of ecosystem types, water chemistry, aquatic environments, and regions of the state containing differing preponderance of land-use types.

There are approximately 380 lakes stocked annually with catchable trout (WDFW, 2004). However, few of these lakes have any contaminant data. Therefore, criterion (1) will be assumed met unless a potential contaminant source is obvious. To verify that criterion (2) is met, regional fish biologists with WDFW will be contacted for local knowledge of natural fish production. Hatchery trout should also be distinguishable from wild fish based on scale annuli patterns (John Sneva, WDFW, Personal Communication 2/10/05). To satisfy criteria (3) and (4), all lakes in the state stocked in 2004 by WDFW with catchable rainbow trout were screened for single hatchery stocking, planting done in a single event or closely spaced plants occurring between early March and late April, and lakes where at least 1,000 rainbow trout were planted. The list of candidate lakes using these screening criteria is in Appendix B.

Sampling Procedures

Hatchery feed and pre-plant catchable rainbow trout samples will be collected at the hatcheries. If more than one manufacturer's batch is used, equal aliquots of each batch will be used to form a composite sample and placed in a 4-ounce glass jar with Teflon lid liner and certificate of analysis. Ten rainbow trout measuring 8-12 inches will be selected at random from hatcheries. Ten post-plant rainbow trout will be collected from each lake using electroshocking, hook and line, fyke net, or gill nets. Following capture from hatcheries or lakes, all fish will be killed with a blow to the head, weighed to the nearest gram and measured to the nearest millimeter, assigned a sample number, double wrapped in aluminum foil, placed in polyethylene bags, and transported on ice to Ecology headquarters where they will be stored frozen at -20^{0} C.

When ready for processing, fish will be partially thawed then scales and otoliths will be removed (lake fish only) for aging by WDFW. Composite samples of homogenate tissue will be prepared by methods described by EPA and Washington State Toxics Monitoring Program for screening level assessments of contaminants in fish tissue (EPA, 2000; Seiders, 2003). Briefly, fish will be scaled, fillets removed, and equal mass aliquots of tissue from ten specimens will be homogenized with three passes through a Kitchen-Aid food processor for each composite. Homogenates will be placed in a 4-ounce glass jar with Teflon lid liner and certificate of analysis and stored frozen.

All resection will be done with non-corrosive stainless steel implements. Persons preparing samples will wear non-talc polyethylene or nitrile gloves and work on aluminum foil or a polyethylene cutting board. Gloves and foil will be changed between samples. The cutting board and knives will be cleaned using Liquinox® detergent and hot tap water, followed by rinses with deionized water, pesticide grade acetone, and pesticide grade hexane. Implements will be air dried in a fume hood before use.

Measurement Procedures

Table 4 shows analytical methods to be used and required reporting limits. The complete list of analytes is in Appendix C. Samples for chlorinated pesticide/PCB/PBDE will be analyzed by MEL using GC/ECD and GC/MS. PCDDs/PCDFs will be analyzed by a contract laboratory using high resolution GC/MS. Percent lipid will be analyzed gravimetrically at MEL.

Table 4. Methods for Analysis of Feed and Tissue.

Parameter	Reporting limits	Expected range of results	Sample preparation method	Analysis method
Chlorinated pesticides	0.1-1* ng/g ww	<0.1-10 ng/g ww	EPA 3540/3620/3665	EPA 8081, MEL SOP #730002
PCBs (as Aroclors)	2.5 ng/g ww	<2.5-50 ng/g ww	“	EPA 8082, MEL SOP #730002
PBDEs	0.5 **ng/g ww	<0.5-10 ng/g ww	“	EPA 8270, MEL SOP #730096
PCDDs/PCDFs	0.1-1 pg/g ww	<0.1-2 pg/g ww	na	EPA 1613B
Percent lipids	0.1%	1-5%	na	MEL SOP #730009

*except toxaphene (20 ng/g ww)
**except PBDE-209 (2.5 ng/g ww)
na=not applicable

Quality Control Procedures

Field

Field activities carried out in the manner described in Sampling Procedures will prevent contamination of samples. Nitrile gloves will be worn during sampling. A copy of the Quality Assurance (QA) Project Plan will be carried in the field for reference.

Laboratory

The Quality Control (QC) procedures routinely followed by MEL for the chemical analyses requested will be satisfactory for purposes of this project. A similar routine is expected of the contract laboratory conducting PCDD/PCDF analysis, except the isoptope dilution methodology of Method 1613B precludes the need for matrix spikes. At least one each of the following QC samples will be analyzed per preparation batch (approximately 20 samples):

- Method blank
- Matrix spike
- Laboratory sample duplicate
- Sample extract duplicate
- Laboratory control sample
- Standard reference material

Method blanks are used to identify contamination stemming from the laboratory environment. Matrix spikes are valuable in assessing bias due to matrix interferences. The project lead will identify the sample to be used for the matrix spikes.

Laboratory duplicates will provide an indication of analytical precision and sample homogeneity. Surrogate spikes will be added to all samples and recoveries should provide an indication of overall accuracy at the concentrations used. Accuracy of the data will also be assessed through analysis of laboratory control samples with every batch. All samples will be analyzed within recommended holding times (one year if frozen).

One SRM (NIST 1974b – Organics in Frozen Mussel Tissue) will also be analyzed with each batch of samples to assess overall accuracy of the results. This SRM was selected for the low level of certified chlorinated pesticide and PCB values (0.3-12 ng/g ww). The certificate for NIST 1974b may be found at https://srmors.nist.gov/tables/view_table.cfm?table=109-2.htm.

Data Verification and Validation

Data Verification

MEL will verify all of the results for environmental and QC sample analyses. Data verification reports will be sent to the project manager in the form of case narratives and will include an assessment of MEL's and the contract laboratory's performance in meeting the conditions and requirements set forth in this sampling plan. Case narratives will also include a comparison of QC results with method acceptance criteria, such as precision data, surrogate and spike recoveries, laboratory control sample analysis, and procedural blanks. QC checks on instrument performance, such as initial and continuing calibrations, will also be noted. Results of standard reference material analysis will be reported along with certified values in the case narratives. MEL will explain flags or qualifiers assigned to sample results. The contract laboratory will report PCDD/PCDF data in a format compatible with Ecology's EIM database.

Data Validation

The project manager will examine the complete data package in detail to determine whether the procedures in the methods, SOPs, and QA Project Plan were followed.

Precision obtained at the laboratory will be assessed by calculating RPDs for the laboratory duplicates. Bias will be calculated as deviations of mean percent recoveries of surrogate spike and laboratory control sample analyses. Accuracy will be assessed by calculating the percent differences from the certified SRM values. Consistently low, or high, recoveries may indicate the data are biased in that direction. Wide ranges in recovery values may indicate data are of questionable accuracy, but do not indicate bias in any particular direction. Matrix spike recoveries will indicate if bias is present due to matrix effects.

Completeness will be assessed through the following accounting:

- Number of samples collected compared to sampling plan.
- Number of samples shipped and received at MEL and the contract laboratory in good condition.
- Ability of MEL and the contract laboratory to produce usable results for each sample.
- Acceptability of sample results by project lead.

The project manager will periodically assess the field sampling procedures to ensure consistency with this sampling plan or make modifications if necessary. The project manager will review all field notes to ensure quality of the field data. Laboratory results will be reviewed by the project manager to check for reasonableness and consistency with performance and completeness expectations. Any problems with the data will be discussed with chemists at MEL and the contract laboratory.

Data Quality Assessment

The project manager will determine if the reviewed, verified, and validated data are of sufficient quantity and quality to meet the project objectives. A summary of QC sample results will include assessment of laboratory precision, contamination, accuracy, matrix interferences, and the success of QC samples meeting control limits.

There are no specific criteria for evaluating precision and sample homogeneity. However, the relative percent differences calculated from analysis of sample and sample extract duplicates will provide estimates of variability and an indication of the source of the variability. There are no criteria for data usability based on accuracy measurements; but, taken as a whole, assessment of data accuracy will indicate if the data are biased and the direction of bias. Laboratory contamination representing >20% of the reported value will lead to rejection of the result.

Data Analysis

Fish tissue data will be compared to the National Toxics Rule criteria (Table 5). Reporting limits (Appendix C) should be low enough to assess whether these criteria have been exceeded. The Water Quality Program will be informed of lakes with fish exceeding criteria for possible inclusion on the list of impaired waterbodies (i.e. 303(d) list).

A paired sample t-test or Wilcoxon (non-parametric equivalent) will be used to compare the differences between contaminant concentrations in hatchery fish and lakes (stocked from those hatcheries). If <15% of the data are non-detects, ½ the reporting limit will be substituted for the result and a paired t-test will be used if the data meet assumptions of normality. If either ≥15% of the results are non-detects or the data are not normally distributed, the rank-order, non-parametric Wilcoxon test will be used with non-detects replaced with zero.

Table 5. National Toxics Rule (NTR) Criteria for Target Analytes. Other Analytes Do Not Have NTR Criteria.

Analyte	Criterion (ng/g ww)	Analyte	Criterion (ng/g ww)	Analyte	Criterion (ng/g ww)
2,3,7,8-TCDD	0.00007	Endrin Aldehyde	3,216	Endosulfan Sulfate	540
4,4'-DDT	32	alpha-BHC	1.7	Heptachlor	2.4
4,4'-DDE	32	beta-BHC	1.6	Heptachlor Epoxide	1.2
4,4'-DDD	45	gamma-BHC (Lindane)	8.2	Hexachlorobenzene	6.7
Aldrin	0.65	Chlordane (total)	8.3	PCB (total)	5.3
Dieldrin	0.65	Endosulfan I	540	Toxaphene	9.8
Endrin	3,216	Endosulfan II	540		

Reports

The project manager will complete a draft report of the study results by September 2005. A final report will be prepared after a peer review comment period. At a minimum, the report will contain the following:

- A description of the study.
- A summary of the project objectives and work performed.
- A map of the study area showing sampling sites.
- Descriptions of field and laboratory methods used in the study.
- A discussion of data quality and the significance of any problems encountered in the analyses.
- Data collected in the field including location information for each sampling site, water quality and land use characteristics of basins where lakes are located, and details of the hatcheries sampled.
- Details of the samples analyzed (including a description of the feed ingredients and sources of the ingredients, if available) and biological information and feeding regime for fish specimens.
- Summary tables of the chemistry data.
- Tables and graphs showing contaminant data for samples related by feed types, hatcheries, and lakes.
- Comparisons between pre- and post-plant fish tissue.
- Comparisons between National Toxics Rule criteria and contaminant levels in fish captured from lakes.
- Discussion of contaminants in hatchery feed, depuration or uptake of contaminants in lakes, and possible sources of contaminants particularly as it relates to accumulation in fish.
- Discussion of implications for the Federal Clean Water Act requirements such as 303(d) listing and TMDLs.
- Recommendations for follow-up work.
- Appendices showing all relevant quality assurance and sample data.

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Appendices

Appendix A

Glossary of Acronyms and Units

303(d) - Section 303(d) of the Federal Clean Water Act
Ecology - Washington State Department of Ecology
ECD - Electron Capture Detector
EIM - Environmental Information Management
EPA - U.S. Environmental Protection Agency
GC - Gas Chromatography
MEL - Manchester Environmental Laboratory
MS - Mass Spectrometry
NIST - National Institute of Standards and Technology
NTR - National Toxics Rule
QA - Quality Assurance
QC - Quality Control
PBDE - PolyBrominated Diphenyl Ether
PCB - Polychlorinated Biphenyl
PCDD - Polychlorinated Dibenzo-*p*-dioxin
PCDF - Polychlorinated Dibenzofuran
RPD - Relative Percent Difference
SRM - Standard Reference Material
WDFW - Washington Department of Fish and Wildlife
WSTMP - Washington State Toxics Monitoring Program
ww - Wet Weight

Units

ng/g – Nanograms Per Gram (Parts Per Billion)
pg/g –Picograms Per Gram (Parts Per Trillion)

Appendix B

Candidate Lakes

Table B-1. Candidate Lakes for Study of Bioaccumulative Chemicals in Fish Hatcheries.

Lake	County	Rg.	fish/lb	Stock date	1 src?	Hatchery	Launch?	Notes
Headgate Pond	Asotin	1	4.2	md Apr	Yes	Tucannon	No	Single plant
Ferry	Ferry	1	5	md Apr	Yes	Ford	No	Single plant
Fish	Ferry	1	5	md Apr	Yes	Ford	No	Single plant
Ellen	Ferry	1	5	ea Apr	Yes	Ford	No	Single plant
Casey Pond	Garfield	1	4.1	lt Apr	Yes	Tucannon	No	Single plant
4th of July	Lincoln	1	5	ea Mar	Yes	Ford	Yes	Single plant
Upper Twin	Lincoln	1	5	ea Mar	Yes	Ford	No	Single plant
Sprague	Lincoln	1	5.5/3.1	lt Feb - ea Mar	No	Ford/Lyons Ferry	Yes	low PCB in WSTMP RBT (2003)
Coffeepot	Lincoln	1	5.5	md Mar	Yes	Ford	No	All fish were adipose fin-clipped
Fan	Pend Oreille	1	5	lt Mar	Yes	Ford	Yes	Single plant
Horseshoe	Pend Oreille	1	5	lt Mar - ea Apr	Yes	Ford	Yes	plant 2 weeks apart
Sacheen	Pend Oreille	1	5	lt Mar	Yes	Ford	Yes	Single plant
Chapman	Spokane	1	5	ea Apr	Yes	Ford	No	Single plant
Downs	Spokane	1	5	ea Mar	Yes	Ford	No	Single plant
Horseshoe	Spokane	1	5	lt Mar	Yes	Ford	No	Single plant
Newman	Spokane	1	5	md Mar - lt Mar	Yes	Ford	Yes	plant 1 week apart
West Medical*	Spokane	1	*	*	*	Spokane/*	Yes	medium PCB in WSTMP RBT (2003)
Deer	Stevens	1	5	lt Mar	Yes	Ford	Yes	plant 3 days apart, brook trout also planted in fall
Jump-Off-Joe	Stevens	1	5	lt Mar	Yes	Ford	Yes	Single plant, brown trout also planted
Garfield Pond	Whitman	1	4.4	md Apr	Yes	Tucannon	No	Single plant
Gilchrist Pond	Whitman	1	4.4	md Apr	Yes	Tucannon	No	Single plant
Big Bow Pond	Douglas	2	3	lt Mar	Yes	Chelan	No	Single plant, also 85 3-pounders stocked on same date
Blue	Grant	2	4.1	lt Mar	Yes	Columbia Basin	No	Single plant, also 200 3.5-pounders stocked on same date
Molson	Okanogan	2	3.2/3.4	md Apr	Yes	Chelan	No	Single plant
Sidley	Okanogan	2	3.2	md Apr	Yes	Chelan	Yes	Single plant
Cranberry	Island	4	3.9	lt Apr	Yes	Arlington	No	Single plant
Deer	Island	4	1.8/4.1	md Apr	Yes	Arlington	No	plant 3 days apart
Goss	Island	4	2/3.7	lt Mar	Yes	Arlington	No	Single plant

Table B-1 (Cont'd). Candidate Lakes for Study of Bioaccumulative Chemicals in Fish Hatcheries.

Lake	County	Rg.	fish/lb	Stock date	1 src?	Hatchery	Pb. Lnch?	Notes
Lone	Island	4	3.7/0.7	lt Mar - md Apr	No	Arlington/Tokul Cr	Yes	EPA lakes study showed RBT fillet=3.4ppb PCB
Bitter	King	4	2.8	lt Mar	Yes	Puyallup	No	Single plant
Boren	King	4	2.8	lt Mar	Yes	Puyallup	Yes	Single plant
Deep	King	4	3/2.5	md Mar - lt Apr	Yes	Puyallup	No	plant 5 weeks apart
Desire	King	4	2.8	lt Mar	Yes	Puyallup	Yes	Single plant
Doloff	King	4	2.9	lt Mar	Yes	Puyallup	Yes	Single plant
Echo 99	King	4	2.7	ea Apr	Yes	Puyallup	No	Single plant
Fenwick	King	4	3.5	lt Mar	Yes	Puyallup	No	Single plant
Fish	King	4	3	md Mar	Yes	Puyallup	Yes	Single plant
Fivemile	King	4	3.2	lt Mar	Yes	Puyallup	No	Single plant
Geneva	King	4	3.2	md Apr	Yes	Puyallup	Yes	Single plant
Haller	King	4	2.8	lt Mar	Yes	Puyallup	No	Single plant
Holm	King	4	3	md Mar	Yes	Puyallup	Yes	Single plant
Killarney	King	4	2.8/2.7	lt Mar - ea Apr	Yes	Puyallup	Yes	plant 1 week apart
Morton	King	4	3.2/2.8	md Mar	Yes	Puyallup	Yes	Single plant
North	King	4	3.3	md Apr	Yes	Puyallup	Yes	Single plant
Shadow	King	4	3.5	lt Mar	Yes	Puyallup	Yes	Single plant
Spring	King	4	2.8	lt Mar	Yes	Puyallup	Yes	Single plant
Star	King	4	3.7	lt Mar	Yes	Puyallup	No	Single plant
Steele	King	4	3.5/2.5	md Apr - lt Apr	Yes	Puyallup	Yes	plant 1 week apart
Trout	King	4	3.2	lt Mar	Yes	Puyallup	No	Single plant
Twelve	King	4	3/3.3	md Mar - lt Apr	Yes	Puyallup	Yes	plant 6 weeks apart
Walker	King	4	2.5	lt Apr	Yes	Puyallup	Yes	Single plant
Wilderness	King	4	2.1	lt Apr	Yes	Puyallup	Yes	Single plant
Bosworth	Snohomish	4	3.8/1.8	lt Apr	Yes	Arlington	Yes	plants on consecutive days
Chain	Snohomish	4	4.5	md Mar	Yes	Arlington	Yes	Single plant
Crabapple	Snohomish	4	4.2	ea Apr	Yes	Arlington	Yes	Single plant
Echo	Snohomish	4	4	ea Apr	Yes	Arlington	Yes	Single plant
Forston Pond	Snohomish	4	1.8	lt Apr	Yes	Arlington	Yes	Single plant
Ketchum	Snohomish	4	4.2	ea Apr	Yes	Arlington	Yes	Single plant
Loma	Snohomish	4	4.1	ea Apr	Yes	Arlington	Yes	Single plant
McMurray	Snohomish	4	1.9	md Apr	Yes	Arlington	No	Single plant

Table B-1 (Cont'd). Candidate Lakes for Study of Bioaccumulative Chemicals in Fish Hatcheries.

Lake	County	Rg.	fish/lb	Stock date	1 src?	Hatchery	Pb. Lnch?	Notes
Serene	Snohomish	4	2.2/4.1	lt Mar - md Apr	Yes	Arlington	Yes	plant 3 weeks apart
Stickney	Snohomish	4	3.7	lt Mar	Yes	Arlington	Yes	Single plant
Wagner	Snohomish	4	3.9	md Apr	Yes	Arlington	Yes	Single plant
Lacamas	Clark	5	2.0/3.2	ea Mar - md Apr	No	Vancouver	Yes	low PCB in WSTMP BT (2003), Troutlodge tripl. (1.6 lb) also planted
Borst Park Pond	Lewis	5	3.2	lt Apr	Yes	Mossyrock	No	Single plant
Davis	Lewis	5	3.3	lt Apr	Yes	Mossyrock	No	Single plant
Plummer	Lewis	5	3.3	md Apr	Yes	Mossyrock	No	Single plant
Siler Pond	Lewis	5	3.3	lt Apr	Yes	Mossyrock	No	Single plant
S.Lewis Co. Park Pond	Lewis	5	3.2	md Apr	Yes	Mossyrock	No	Single plant, brown trout also planted ea Apr
Swofford	Lewis	5	3.3	lt Mar - md Apr	Yes	Mossyrock	No	Single plant, brown trout also planted ea Apr
Ludlow	Jefferson	6	3.4	md Apr	Yes	Eells Springs	No	Single plant
Buck	Kitsap	6	3.4	ea Apr	Yes	Eells Springs	Yes	Single plant
Island	Kitsap	6	3.6	md Mar	Yes	Eells Springs	No	cutthroat also planted
Kitsap	Kitsap	6	3.8/3.5	md Mar - lt Apr	Yes	Eells Springs	Yes	plant 6 weeks apart
Mission	Kitsap	6	0.4/3.5	lt Mar - md Apr	Yes	Eells Springs	Yes	plant 2 weeks apart
Panther	Kitsap	6	0.4/3.5	lt Mar - ea Apr	Yes	Eells Springs	Yes	plant 1 week apart
Benson	Mason	6	3.4/0.7	ea Apr - md Apr	Yes	Eells Springs	Yes	plant 1 week apart
Devereaux	Mason	6	0.4/3.7	lt Mar - ea Apr	Yes	Eells Springs	Yes	plant 2 weeks apart
Haven	Mason	6	3.4	md Apr	Yes	Eells Springs	Yes	Single plant
Isabella	Mason	6	3.6	md Mar	Yes	Eells Springs	Yes	Single plant
Island	Mason	6	3.8	md Mar	Yes	Eells Springs	Yes	cutthroat also planted
Kokanee	Mason	6	3	lt Mar	Yes	Eells Springs	No	Single plant
Limerick	Mason	6	3.6/3.5	ea Apr - md Apr	Yes	Eells Springs	Yes	plant 2 weeks apart
Lost	Mason	6	3.6	lt Mar	Yes	Eells Springs	Yes	Single plant
Maggie	Mason	6	3.5/0.4	md Apr	Yes	Eells Springs	Yes	Single plant
Robbins	Mason	6	3.5	md Apr	Yes	Eells Springs	No	Single plant
American	Pierce	6	3.2	md Mar	Yes	Puyallup	Yes	Single plant
Carney	Pierce	6	3.4	md Apr	Yes	Eells Springs	Yes	Single plant
Carter	Pierce	6	2.7	ea Apr	Yes	Puyallup	No	Single plant
Clear	Pierce	6	2.1	lt Apr	Yes	Puyallup	Yes	Single plant
Crescent	Pierce	6	3.4/3.5	ea Apr	Yes	Eells Springs	Yes	plants on consecutive days
Eatonville Pond	Pierce	6	2.5	lt Apr	Yes	Puyallup	No	Single plant
Kapowsin	Pierce	6	2.6/3.2	md Mar - md Apr	Yes	Puyallup	No	plant 5 weeks apart

Table B-1 (Cont'd). Candidate Lakes for Study of Bioaccumulative Chemicals in Fish Hatcheries.

Lake	County	Rg.	fish/lb	Stock date	1 src?	Hatchery	Pb. Lnch?	Notes
Wapato	Pierce	6	3.2/2.7	md Mar - ea Apr	Yes	Puyallup	No	plant 4 weeks apart
Waughop	Pierce	6	3.2	md Mar - md Apr	Yes	Puyallup	No	plant 5 weeks apart
Clear	Thurston	6	3.7/3.4	lt Mar - md Apr	Yes	Eells Springs	Yes	plant 2 weeks apart
Deep	Thurston	6	3.5/3.4	ea Apr	Yes	Eells Springs	No	plant 1 week apart
Lawrence	Thurston	6	3.6	md Mar	Yes	Eells Springs	Yes	Single plant
Long	Thurston	6	0.4/3.6	lt Mar - md Apr	Yes	Eells Springs	Yes	7 plants
Pattison	Thurston	6	0.4/3.5	lt Mar - lt Apr	Yes	Eells Springs	Yes	7 plants
Summit	Thurston	6	0.4/3.7	md Mar - md Apr	Yes	Eells Springs	Yes	10 plants

*Data on planting to be provided by Chris Donley (WDFW)

Appendix C

Target Analytes and Reporting Limits

Table C-1. Target Analytes and Reporting Limits.

Analyte	Reporting Limit (ng/g ww)	Analyte	Reporting Limit (ng/g ww)	Analyte	Reporting Limit (pg/g ww)
Chlorinated Pesticides		PCBs		PCDDs/PCDFs	
2,4'-DDE	0.5	Aroclor-1016	2.5	2,3,7,8-TCDD	0.7
2,4'-DDD	0.5	Aroclor-1221	2.5	1,2,3,7,8-PeCDD	0.5
2,4'-DDT	0.5	Aroclor-1232	2.5	1,2,3,4,7,8-HxCDD	0.6
4,4'-DDT	0.5	Aroclor-1242	2.5	1,2,3,6,7,8-HxCDD	0.6
4,4'-DDE	0.5	Aroclor-1248	2.5	1,2,3,7,8,9-HxCDD	0.6
4,4'-DDD	0.5	Aroclor-1254	2.5	1,2,3,4,6,7,8-HpCDD	0.9
DDMU	0.5	Aroclor-1260	2.5	OCDD	0.8
Aldrin	0.6			2,3,7,8-TCDF	0.3
Dieldrin	0.6	PBDEs		1,2,3,7,8-PeCDF	0.9
Endrin	1.0	PBDE-47	0.5	2,3,4,7,8-PeCDF	0.3
Endrin Aldehyde	1.0	PBDE-66	0.5	1,2,3,4,7,8-HxCDF	0.6
Endrin Ketone	1.0	PBDE-71	0.5	1,2,3,6,7,8-HxCDF	0.6
alpha-BHC	0.5	PBDE-99	0.5	2,3,4,6,7,8-HxCDF	0.6
beta-BHC	0.5	PBDE-100	0.5	1,2,3,7,8,9-HxCDF	0.6
gamma-BHC (Lindane)	0.5	PBDE-138	0.5	1,2,3,4,6,7,8-HpCDF	0.3
delta-BHC	0.5	PBDE-153	0.5	1,2,3,4,7,8,9-HpCDF	0.7
cis-Chlordane (alpha)	0.3	PBDE-154	0.5	OCDF	0.9
trans-Chlordane (gamma)	0.3	PBDE-183	0.5		
Oxychlordane	0.3	PBDE-190	0.5		
alpha-Chlordene	0.3	PBDE-209	2.5		
gamma-Chlordene	0.3				
Dacthal (DCPA)	1.0				
Endosulfan I	1.0				
Endosulfan II	1.0				
Endosulfan Sulfate	1.0				
Heptachlor	0.2				
Heptachlor Epoxide	0.2				
Hexachlorobenzene	0.1				
Methoxychlor	1.0				
Mirex	0.1				
cis-Nonachlor	0.3				
trans-Nonachlor	0.3				
Pentachloroanisole	0.2				
Toxaphene	20				